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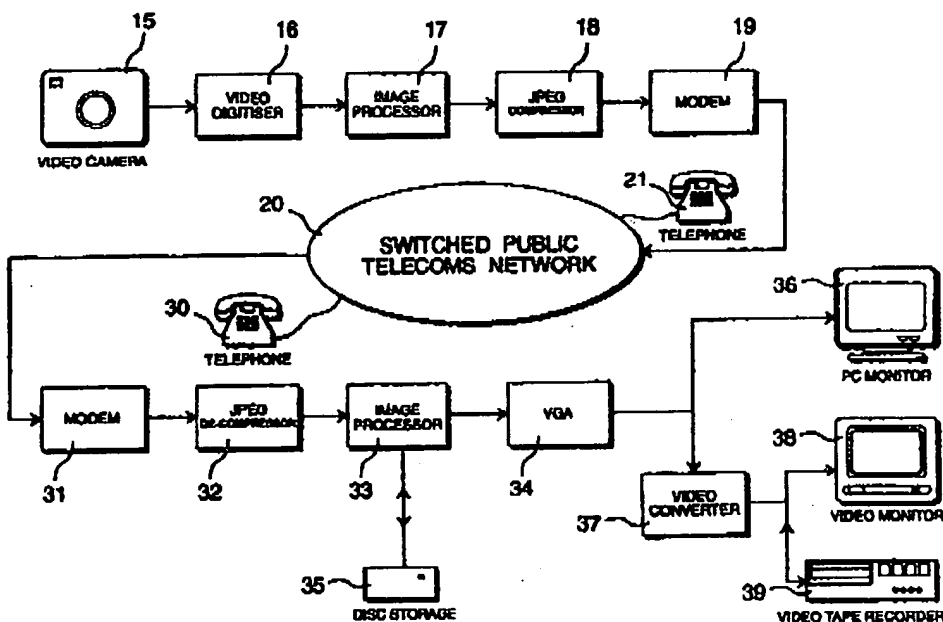
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(58) Field of Search

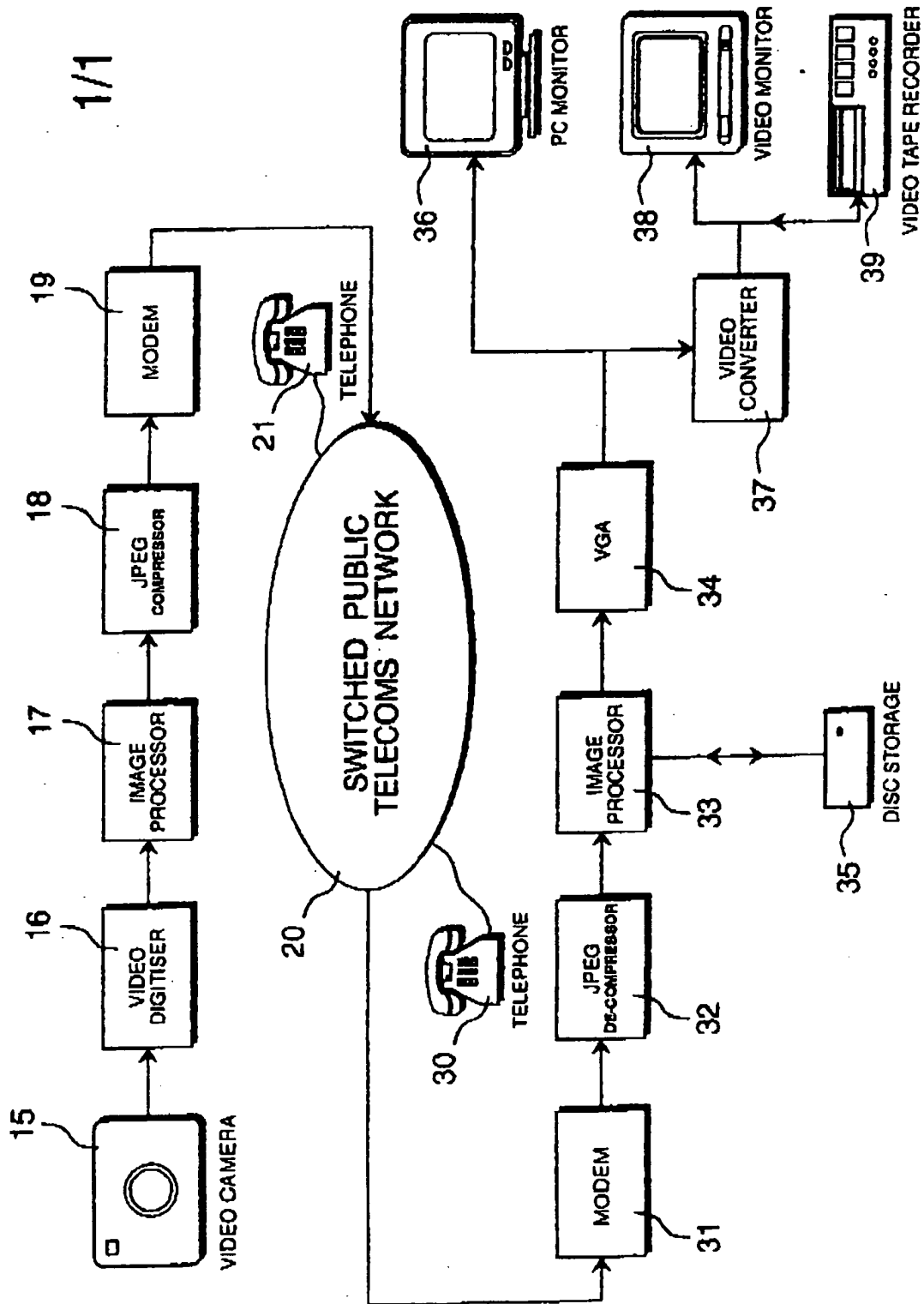
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(54) Diagnostic method and apparatus

(57) Diagnosis of skin conditions is facilitated by connecting remote operators to an expert consultant over a switched telecommunications network 20. At an operator's station, electrical signals are generated by means of a video camera 15. Images produced by said camera are digitised and compressed prior to transmission over the network. At the expert's station, transmitted data is de-compressed and reconstituted for display and storage. The system allows a consultant dermatologist to receive images of skin conditions from a plurality of general practitioners.



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DIAGNOSTIC METHOD AND APPARATUS

The present invention relates to diagnosis, in which a remote operator communicates with an expert consultant.

5 In particular, the present invention facilitates the diagnosis of medical conditions in which there is a visual symptom, such as a skin condition. The present invention is particularly useful for obtaining a diagnosis from a consultant dermatologist.

10 At the present time, if a patient attends their general practitioner with a skin complaint and the general practitioner considers it appropriate to obtain the opinion of a consultant dermatologist, the normal way of proceeding would be for the general practitioner to send to the consultant dermatologist a very brief written description of the position and appearance of the patient's symptom. Such information in practice will very often be inadequate to enable the consultant dermatologist to give a considered opinion as to the
15 nature of the complaint.

Furthermore, because of the relatively small number of consultant dermatologists in relation to the volume of skin related complaints, these written referrals by general practitioners have the effect of overloading the consultant dermatologists' appointments' lists.

20 According to a first aspect of the present invention, there is provided a method of diagnosis, in which a remote operator communicates with an expert consultant, comprising the steps of generating an electrical signal at an operator's station of an image to be conveyed to an expert's station; digitising said electrical signal to produce an original digitised video image;

compressing said video image; transmitting said video image to the expert's station; de-compressing said transmitted image data to substantially re-constitute said original digitised video image; and producing a displayable image from said de-compressed image data.

5 An advantage of the present invention is that it allows a remote operator, possibly a general practitioner say, to relay pictures to an expert consultant. In this way, the consultant may give a real time diagnosis and an immediate decision may be taken as to whether further action is required.

10 Alternatively the image may be stored in memory and reconstituted at a later date to enable the consultant to review the pictures out of clinic hours, i.e. the system can be used off-line as well as in real time.

An advantage of this system to the consultant dermatologist is that it will be able to TRIAGE suspicious pigmented lesions, e.g. moles and possible skin cancers, enabling a more rapid referral to be generated if appropriate.
15 It can be used to manage a consultant dermatologist's waiting list.

The invention will now be described by way of example only, with reference to the accompanying figure which details a system for communicating video images in order to facilitate diagnosis.

20 A system for conveying an image of a patient's skin condition from a first remote station to an expert's station is shown in Figure 1. A remote station includes a video still camera 15, a video digitiser 16, an image processor 17, a JPEG compressor 18 and a modem 19. The modem is connected to a switched public switched telecoms network (PSTN) 20. In addition, a conventional audio telephone set 21 is also connected to said

network, wherein said network provides a one way video link from an operator's station to the expert's station and a two-way audio link.

5 At the expert's station, there is provided a modem 31, a JPEG decompressing circuit 32, an image processor 33 and an image conversion circuit 34 for converting digitised images into displayable images. The expert's station also includes means for displaying and storing images, in addition to an audio telephone 35 which, as previously stated, enables an audio link to be established with a telephone 21.

10 The camera 15 may be a conventional video camera or camcorder arranged to produce a baseband video signal, consisting of interlaced fields at fifty or sixty per second. The video digitiser 16 is arranged to assemble a single frame, consisting of two interlaced fields, and to generate a conventional VGA computer image from said video frame. However, in a preferred embodiment, the camera 15 is arranged to generate single frame
15 images, which are again supplied to the video digitiser 16, which in turn supplies a VGA image to the image processor 17.

20 In alternative embodiments, higher definition systems may be used, which may also define a larger gamut of colours. However, with higher definition systems, such as SBHA compatible systems, transmission time will take proportionally longer.

The video digitiser 16 may be a BTA12 device produced by Booktree Limited and arranged to generate a three hundred and twenty times two hundred and fifty six (320 x 256) pixel image, with two hundred and fifty six (256) color levels at each pixel.

The image processor 17 is preferably included as part of a standard personal computer, such as an IBM personal computer, including an 80486 micro processor with four mega bits of internal randomly accessible memory and one hundred and twenty mega bits of hard storage. With this arrangement, the video digitiser 16 and the JPEG compressor 18 may be include as cards mountable within the housing of the computer. Thus, the image processor 17, effectively the CPU of the personal computer, is arranged, under software control, to implement modest image processing routines, such as color mapping, adjustments to contrast and brightness, and spacial filtering, to effect levels of image enhancement.

As is known in the art, a conventional modem would be capable of transmitting a VGA image in approximately one and a half minutes. However, in the present embodiment, VGA images are compressed by a JPEG compression card 18, to facilitate transmission in as little as ten seconds. However, under software control, the level of compression provided by the JPEG compressor 18 is adjustable, thereby providing a trade off between the level of image compression and transmission time.

A transmission would be initiated by a remote operator contacting the central consultant via telephone device 21, the switched network 20 and telephone device 35. In response to this communication, the consultant would acknowledge that equipment is ready for images to be received and, furthermore, the consultant may provide guidelines as to how images are to be sent over the system. For example, the consultant may request a particular area of the skin to be photographed or a particular area to be enlarged etc. It should therefore be appreciated that the video camera 15 includes macro lenses, allowing very close up shots to be produced.

At the receiving station, the transmitted data is demodulated by modem 31 and supplied to a decompression circuit 32. Again, decompression circuit 32, image processor 33 and VGA convertor 34 are all resident as cards within a personal computer, similar to the personal computer used at the transmitting station.

The output from the image processor 33 is in digital form and, as such, may be supplied directly to a disc storage device 35, which may be resident within the PC housing or may be an additional unit interfaced thereto.

10 The VGA card 34 produces an analog RGB signal which is displayed on a PC monitor 36. In response to the image displayed on the PC monitor 36, the consultant may provide inputs to the image processor 33, effecting further image modifications or enhancements.

15 The output from the VGA card 34 is also supplied to a video convertor card 37, arranged to convert the image into a conventional video compatible image, which may be displayed on a video monitor 38, similar to a conventional television display and to a conventional video tape recorder 39, such as a VHS recorder. Preferably, the video tape recorder 39 is capable of recording good quality images and may therefore be compatible with the super VHS standard or professional Betacam standard.

20 In addition to storing images on video tape, the consultant's station may also include means for generating hard copy images such as an electronic proofer or a photographic convertor.

Clearly, it is possible that a remote general practitioner may wish to transmit signals at times when the consultant is not available. In a preferred

embodiment, the system is provided with remote answering facilities, allowing pictures generated by camera 15 to be automatically supplied to the disc storage device 35 or to the video tape recorder 39. Thus, the telephone 35 could be provided with a telephone answering device arranged to supply
5 an interrupt signal to the consultant's PC, which will in turn initiate a routine to facilitate the automatic transfer of images. Furthermore, the remote operator may be given direct access to the consultant's processor, via a suitable interface generating signalling commands which may be transmitted over the modems 19, 31 and the telephone communications link at 20.

10 As described, the consultant dermatologist would normally be in a position to relay comments and diagnosis back to the operator via the telephone link 35, 21. In addition, the system may also include mechanisms for relaying data and video images back to the operator.

15 As well as the system providing a means by which the productivity of consultant dermatologist's may be increased, in the sense of being able to give a larger number of expert diagnoses in a given time, the system could also be used for educational and promotional purposes. This could be achieved by down loading appropriate data onto a CD ROM, from which screen images and hard copies could be produced.

20 A digital still camera could be used in place of a camcorder, although use of a camcorder or video camera would facilitate the transmission of moving video, in addition or in preference to still video images.

The system could be adapted to provide two-way communication, by providing transmission equipment at the consultant's terminal and reception
25 equipment at the general practitioner's terminal.

A facility may also be provided to the effect that once the consultant has viewed the image, said consultant can call up guidelines for the clinical treatment and management of the medical condition, by a software installed onto the general practitioner's computer.

5 The system of the present invention enables benign lesions, such as warts, to be quickly distinguished from more troublesome lesions, such as skin cancer etc, more quickly, thereby minimising the occasions when a direct referral of the patient is required.

10 The digital image may also be transmitted via E-mail. The image will be sent with an electronic referral front end. Once reconstituted the high resolution colour image will be viewed and an electronic letter sent back with a series of treatment options written by the expert.

15 The image could be captured using a PC with a VC8000 software package sent down ISDN2 lines to produce high definition images which can be stored and forwarded. The images could be sent via a network established by the health authority. There could be interrogation of the image electronically while passing along a "neural" network and creating an artificial intelligence system which could analyse data from the imagery and build it into a database.

CLAIMS

1. A method of diagnosis, in which a remote operator communicates with an expert consultant, comprising steps of

5 generating an electrical signal at an operator's station of an image to be conveyed to an expert's station;

digitising said electrical signal to produce an original digitised video image;

compressing said video image;

transmitting said video image to the expert's station;

10 decompressing said transmitted image data to substantial re-constitute said original digitised video data; and

producing a displayable image from said de-compressed image data either in real time or off-line via memory means.

15 2. A method according to claim 1, wherein said signal is generated by a video still camera.

3. A method according to claim 1, comprising steps of digitising a single frame of a video signal produced by a moving video camera.

4. A method according to claim 1, including digitising a single frame of a video signal produced by a video tape recorder.

5. A method according to any of claims 1 to 4, wherein said video image is compressed in accordance with the JPEG recommendations.

5 6. A method according to claim 5, wherein the degree of compression is adjustable to facilitate control of a trade-off between transmission speed and picture quality.

7. A method according to any of claims 1 to 6, wherein said modulated image is transmitted over the public switched telephone network.

8. A method according to claim 7, wherein an audio link is also provided over said network.

10 9. A method according to any of claims 1 to 6, wherein data is transmitted over a dedicated link.

10. A method according to claim 9, wherein said link is a two-way link, facilitating the two-way transmission of audio data.

15 11. A method according to any of claims 1 to 10, wherein said displayable image is in VGA format.

12. A method according to claim 11, wherein VGA images are stored on recording means.

13. A method according to claim 12, wherein said storage means is a hard disc drive.

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14. A method to any of claims 1 to 10, wherein said displayable image is in video format.

15. A method according to claim 14, wherein said video images are stored on a video tape recorder.